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Office Memorandum • UNITED STATES GOVERNMENT

SPM 6-413

TO : Chief, Engineering Division, OC DATE: 12 December 1956

FROM : Chief, Supplemental Programs Division, OC

SUBJECT: (Contract RD-107, Task Order 4, VLF Antenna Program)

REF : Memorandum No. ENG 6-256

1. It is recommended that the subject Task Order with [redacted] be terminated since nothing more can be accomplished at this time. A final consolidated report should be written by the contractor. 25X1

2. It is requested that the ferrite rods, and any other equipment or models that belong to the government under this Task Order, be shipped to 1712 Alcott Hall for disposition, and that [redacted] of your External Projects Section, obtain the name of the [redacted] manufacturer of ferrite material that is mentioned in the trip report of 14 November 1956. 25X1 25X1

[redacted] 25X1

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ROUTING AND RECORD SHEET

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SUBJECT: (Optional)

FROM: OC-E/R&D-EP

NO.

DATE: 14 November 1956

TO: (Officer designation, room number, and building)	DATE REC'D	DATE FWD'D	OFFICER'S INITIALS	COMMENTS (Number each comment to show from whom to whom. Draw a line across column after each comment.)
1. Chief, Supplemental Division, OC	19 Nov.			H'K Copy sent to AFB
2.				
3.				
4. SP/AP	11/16/56		RCC	
5. OC-SP				what is your recommendation?
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

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FORM 1 DEC 55 610 USE PREVIOUS EDITIONS

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ENG-6-1256

Office Memorandum • UNITED STATES GOVERNMENT

TO : Chief, Supplemental Programs Division, OC DATE: 14 November 1956

FROM : Chief, Engineering Division, OC

SUBJECT: Contract RD-107, Task Order 4, VLF Antenna Program

1. The attached trip report states that [redacted] has stopped work on this task order because they feel that the ferrite antenna designed for a 2 kc bandwidth at 20 kc will not be as sensitive as an equivalent air-core loop antenna. 25X1 25X1

2. Would you please let us know if you would like to terminate the work at this point and if so, what you would like done with the ferrite rods which [redacted] has fabricated. 25X1

[redacted] 25X1

Attachment:

Trip Report

You might like to hash this over with us a bit —

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The Files

14 November 1956

[redacted] 25X1

Trip Report, Contract NO-107, Task Order 4

1. On 5 November 1956 a meeting was held at [redacted] 25X1
[redacted] to discuss the subject contract. Present at 25X1
the meeting were:

[redacted] 25X1

2. Testing of the ferrite antenna under load has disclosed some unexpected and discouraging results. Design efforts to this time have been directed towards achieving maximum effective height (open circuit voltage output) and have been successful. However, upon testing under the specified 72 ohm load it was learned that placing a number of ferrite antennas close together in a matrix did not substantially improve the power output over a single ferrite antenna. It is now believed that there is only a certain amount of energy of a given bandwidth in a given area and that either an air-core loop or an ideal ferrite antenna efficiently collects almost all of that energy. Putting more antennas in the same area will not help, also, if a matrix of ferrite antennas is formed in which each ferrite efficiently collects the energy in its area, the resulting sensitivity will not be greater than the sensitivity of an air-core loop which has an area equal to that of the matrix. The only exception to this rule is the case shown at the end of this report in which two ferrite rods are placed a loop diameter apart. In this case each ferrite captures an area equal to that within the loop yielding a sensitivity twice that of the loop but enclosing a square area slightly greater than the round area enclosed by the loop. Again adding a third ferrite between the first two would not improve the pick-up since its capture area would over-lap with the two outside ferrites.

3. It has also been determined that the present ferrites are not ideal. While the effective height of ferrite loops is considerably greater than that of an air-core loop, the power output is less than half of the equivalent air-core loop. The tabulation below presents power output of a number of antennas, each of which are loaded to yield a 2 kc bandwidth at 20 kc.

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Antenna (single loop or ferrite rod)	Power Out Microwatts	Permeability (intrinsic or toroidal)	Q (Unloaded)
15" dia. air-core	7.9	1	25
[redacted] Ferrite ½" x 15"	3.6	300	200
Ferramic G ½" x 8"	.5	200	225
Ideal Ferrite ½" x 15"	8		150

25X1

25X1

It can be seen that the best [redacted] could do was 3.6 microwatts and even an ideal ferrite with infinite permeability would only slightly exceed the air-core loop. It is believed that these results were obtained because power output, P_o:

$$P_o = \frac{(e_i)^2 \, Q_{(Loaded)}}{\omega L}$$

The effective height as measured by the induced voltage, e_i, of the ferrite antenna was high but the inductive reactance of the ferrites is also very high.

4. In summary, it has been determined that for a given bandwidth, placing cores close together in a matrix will not yield a sensitivity greater than that of an air-core loop with an area the same as the matrix. It has also been determined that for a 2 kc bandwidth, the present ferrite antennas are only half as sensitive as an air-core loop which has a diameter the same as the ferrite length and that the ideal antennas could only equal the air-core loop.

5. Because of these results, all work on this project has stopped pending instructions from us as to what further action is desired. At this time approximately $6,000.00 of the money allocated remains unspent. Approximately thirty (30) specially fabricated ferrite rods are on hand. These rods are ½" in diameter and 15" long, and up to frequencies of one megacycle, maintain a Q of 200 and toroidal permeability of 300.

6. It should be noted that there are certain advantages of single ferrite rods which must be weighed against the fact that they are half as sensitive as the equivalent air-core loop. Under certain circumstances, a round ferrite rod ½" in diameter by 15" long may be easier to conceal than an air-core loop 15" in diameter. Also, referring to the equation given in Paragraph 3, it can be seen that as Q goes up (and bandwidth decreases) power output goes up. The highest Q obtainable in an air-core loop is roughly 50 (yielding a bandwidth of 400 cycles) and its' sensitivity could be equaled by a ferrite antenna with a Q of 100 (bandwidth of 200 cycles).. By using the maximum Q possible, 200, a ferrite antenna would be twice as sensitive as an air-core antenna but would have a

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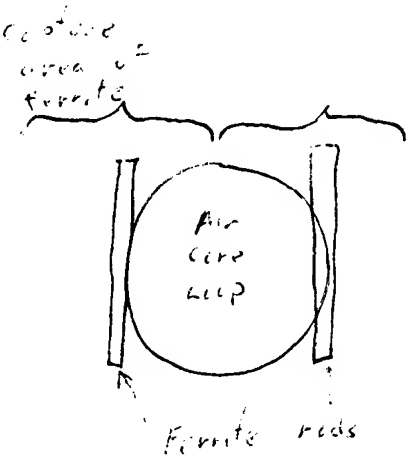
bandwidth of only 100 cycles at 20 kc. Also, two ferrite antennas will not interact if they are tuned to resonate far enough apart. Using their high Q characteristics in this manner, it would be possible to build a matrix of a number of ferrite antennas tuned to different frequencies which would be more sensitive than an air-core loop of equivalent area but the frequency response characteristics would probably have "suck outs" roughly 10 db deep. Also, the ferrite is more directional than the air-core loop and under some circumstances it is possible to eliminate interference from local sources such as electric motors by using this characteristic.

25X1

25X1

OC-E/R&D-EP/TGW:jac (14 November 1956)

cc: R&D Subject File
Monthly Report (2)
SPD
Lab
Dev-ep



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